

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about copper and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Copper has been found in at least 884 of the 1,613 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which copper is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to copper, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and the route of exposure (how you come in contact with it). You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS COPPER?

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and, at low levels, air. Its average concentration in the earth's crust is about 50 parts copper per million parts soil (ppm) or, stated another way, 50 grams of copper per 1,000,000 grams of soil. Copper also occurs naturally in all plants and animals. It is an essential element for all known living organisms including humans and other animals at low levels of intake. At much higher levels, some toxic effects can occur.

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Metallic copper can be easily molded or shaped. The reddish color of this element is most commonly seen in the U.S. penny, electrical wiring, and some water pipes. It is also found in many mixtures of metals, called alloys, such as brass and bronze. Many compounds (substances formed by joining two or more chemicals) of copper exist. These include naturally occurring minerals as well as manufactured chemicals. The most commonly used compound of copper is copper sulfate. Many copper compounds can be recognized by their blue-green color. When we speak of copper, we will not only be referring to copper metal, but also to compounds of copper that may be in the environment.

Copper is extensively mined and processed in the United States and is primarily used as the metal or alloy in the manufacture of wire, sheet metal, pipe, and other metal products. Copper compounds are most commonly used in agriculture to treat plant diseases, like mildew, or for water treatment and as preservatives for wood, leather, and fabrics. For more information on the properties and uses of copper, please see Chapters 4 and 5.

1.2 WHAT HAPPENS TO COPPER WHEN IT ENTERS THE ENVIRONMENT?

Copper can enter the environment through releases from the mining of copper and other metals, and from factories that make or use copper metal or copper compounds. Copper can also enter the environment through domestic waste water, combustion of fossil fuels and wastes, wood production, phosphate fertilizer production, and natural sources (for example, windblown dust, from native soils, volcanoes, decaying vegetation, forest fires, and sea spray). Therefore, copper is widespread in the environment. About 1,400,000,000 pounds of copper were released into the environment by industries in 2000. Copper is often found near mines, smelters, industrial settings, landfills, and waste disposal sites.

When copper is released into soil, it typically becomes strongly attached to the organic material and minerals in the top layers of soil and does not move very far when it is released. When copper is released into water, the copper that dissolves can be carried in surface waters either as free copper or, more likely, bound to particles suspended in the water. Because copper binds so strongly to suspended particles and sediments, it typically does not enter groundwater. Copper

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that enters water eventually collects in the sediments of rivers, lakes, and estuaries. Copper is carried on particles emitted from smelters and ore processing plants, and is then carried back to earth through gravity or in rain or snow. Copper is also carried into the air on windblown metallurgical dust. Indoor release of copper comes mainly from combustion processes (for example, kerosene heaters).

Copper does not break down in the environment. Copper can be found in plants and animals, and at high concentrations in mussels and oysters. Copper is also found in a range of concentrations in many foods and beverages that we eat and drink, including drinking water. You will find additional information on the fate of copper in the environment in Chapters 5 and 6.

1.3 HOW MIGHT I BE EXPOSED TO COPPER?

Copper is common in the environment. You may be exposed to copper by breathing air, drinking water, eating food, and by skin contact with soil, water, and other copper-containing substances. Most copper compounds found in air, water, sediment, soil, and rock are so strongly attached to dust and dirt or imbedded in minerals. However, you can still be exposed to copper upon ingestion of water or soil that contains copper or, to a lesser extent, by inhalation of copper-containing dust. Some copper in the environment is less tightly bound to particles and may be taken up by plants and animals. Soluble copper compounds (those that dissolve in water), which are most commonly used in agriculture, are more likely to threaten your health. When soluble copper compounds are released into lakes and rivers, they generally become attached to particles in the water within approximately 1 day. This could lessen your exposure to copper in water, depending on how strongly the copper is bound to the particles and how much of the particles settle into lake and river sediments.

The concentration of copper in air ranges from a few nanograms (1 nanogram equals 1/1,000,000,000 of a gram) in a cubic meter of air (ng/m^3) to about $200 \text{ ng}/\text{m}^3$. Near smelters, which process copper ore into metal, concentrations may reach $5,000 \text{ ng}/\text{m}^3$. You may breathe

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high levels of copper-containing dust if you live or work near copper mines or processing facilities.

You may be exposed to high levels of soluble copper in your drinking water, especially if your water is corrosive and you have copper plumbing and brass water fixtures. The average concentration of copper in tap water ranges from 20 to 75 parts copper per billion parts water (ppb). However, many households have copper concentrations of over 1,000 ppb. That is more than 1 milligram per liter of water. This is because copper is picked up from copper pipes and brass faucets when the water sits in the pipes overnight. After the water is allowed to run for 15–30 seconds, the concentration of copper in the water decreases.

The average concentration of copper in lakes and rivers is 4 ppb. The average copper concentration in groundwater is similar to that in lakes and rivers; however, monitoring data indicate that some groundwater contains higher levels of copper. This copper is generally strongly attached to particles in the water. Lakes and reservoirs recently treated with copper compounds to control algae or receive cooling water from a power plant may have high concentrations of dissolved copper. Once in natural water, much of this copper soon attaches to particles or converts to forms that can settle into sediments. This can limit exposure to copper unless the sediments are stirred; for example, by the resuspension and swallowing of sediments by swimmers in recreational waters.

Garden products containing copper that are used to control certain plant diseases are also a potential source of exposure. For example, you can find copper compounds in some fungicides.

Soil generally contains between 2 and 250 ppm copper, although concentrations close to 17,000 ppm have been found near copper and brass production facilities. High concentrations of copper may be found in soil because dust from these industries settles out of the air, or wastes from mining and other copper industries are disposed of on the soil. Another common source of copper in soil results from spreading sludge from sewage treatment plants. This copper generally stays strongly attached to the surface layer of soil. You may be exposed to this copper

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by skin contact. Children may also be exposed to this copper by eating the dirt and dust generated therefrom.

Food naturally contains copper. You eat and drink about 1 milligram (1/1,000 of a gram) of copper every day. Copper is essential in your diet for good health.

While some hazardous waste sites on the NPL contain high levels of copper, we do not always know how high it is above natural levels. We also do not know what form it is in at most of these sites. However, evidence suggests that most copper at these sites is strongly attached to soil.

You may be exposed to copper in the workplace. If you work in the industry of mining copper or processing the ore, you are exposed to copper by breathing copper-containing dust or by skin contact. If you grind or weld copper metal, you may breathe high levels of copper dust and fumes. Occupational exposure to forms of copper that are soluble or not strongly attached to dust or dirt would most commonly occur in agriculture, water treatment, and industries such as electroplating, where soluble copper compounds are used.

For more information on the potential for exposure to copper, please refer to Chapter 6.

1.4 HOW CAN COPPER ENTER AND LEAVE MY BODY?

Copper can enter your body when you drink water or eat food, soil, or other substances that contain copper. Copper can also enter your body if you breathe air or dust containing copper. Copper may enter the lungs of workers exposed to copper dust or fumes.

Copper rapidly enters the bloodstream and is distributed throughout the body after you eat or drink it. Other foods eaten with copper can affect the amount of copper that enters the bloodstream. Your body is very good at blocking high levels of copper from entering the bloodstream. We do not know how much copper enters the body through the lungs or skin. Copper then leaves your body in feces and urine, mostly in feces. It takes several days for

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copper to leave your body. Generally, the amount of copper in your body remains constant (the amount that enters your body equals the amount that leaves). More information on how copper enters and leaves the body is presented in Chapter 3.

1.5 HOW CAN COPPER AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Copper is essential for good health. However, exposure to higher doses can be harmful. Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. If you drink water that contains higher than normal levels of copper, you may experience vomiting, diarrhea, stomach cramps, and nausea. Intentionally high intakes of copper can cause liver and kidney damage and even death. We do not know if copper can cause cancer in humans. EPA has determined that copper is not classifiable as to human carcinogenicity.

More detailed information on the health effects of copper in animals and humans can be found in Chapter 3.

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1.6 HOW CAN COPPER AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Exposure to high levels of copper will result in the same types of effects in children and adults. We do not know if children are more susceptible to the toxicity of copper than adults. Studies in animals suggest that children may have more severe effects than adults; we do not know if this would also be true in humans. There is a very small percentage of infants and children who are unusually sensitive to copper. We do not know if copper can cause birth defects or other developmental effects in humans. Studies in animals suggest that ingestion of high levels of copper may cause a decrease in fetal growth.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO COPPER?

If your doctor finds that you have been exposed to significant amounts of copper, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate. The greatest potential source of copper exposure is through drinking water, especially in water that is first drawn in the morning after sitting in copper piping and brass faucets overnight. To reduce copper in drinking water, run the water for at least 15–30 seconds before using it.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO COPPER?

Copper is normally found in all tissues of the body, blood, urine, feces, hair, and nails. High levels of copper in the blood, urine, hair, and nails can show that you have been exposed to higher than normal levels of copper. Tests to measure copper levels in the body are not usually available at a doctor's office because they require special equipment. Although these tests can show that you have been exposed to higher than normal copper levels, they can not be used to

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predict the extent of exposure or potential health effects. More detailed information on the measurement of copper is provided in Chapters 3 and 7.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA).

Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for copper include the following:

EPA has determined that drinking water should not contain more than 1.3 mg copper per liter of water (1.3 mg/L). EPA has developed regulations on the amount of copper released by industry.

OSHA has set a limit of 0.1 milligrams/cubic meter (mg/m³) of copper fumes (vapor generated from heating copper) and 1.0 mg/m³ of copper dusts (fine metallic copper particles) and mists

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(aerosol of soluble copper) in workroom air to protect workers during an 8-hour work shift (40-hour workweek).

The Food and Nutrition Board of the Institute of Medicine has developed recommended dietary allowances (RDAs) of 340 micrograms (μg) of copper per day for children aged 1–3 years, 440 $\mu\text{g}/\text{day}$ for children aged 4–8 years, 700 $\mu\text{g}/\text{day}$ for children aged 9–13 years, 890 $\mu\text{g}/\text{day}$ for children aged 14–18 years, and 900 $\mu\text{g}/\text{day}$ for adults. This provides enough copper to maintain health. Further information on regulations and guidelines pertaining to copper is provided in Chapter 8.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333
Web site: <http://www.atsdr.cdc.gov>

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737)
Fax: 1-404-498-0057

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

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* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000